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HUMAN NATURE IN SCIENCE[1]

By Dr. JOHN K. WRIGHT

AMERICAN GEOGRAPHICAL SOCIETY, NEW YORK

THE Executive Committee has asked that emphasis be placed throughout this session of the association on "the indispensability of science for the future of civilization." This seems a little like putting the cart before the horse. If civilization were to disappear there would be no science, and science will contribute nothing to civilization if men of science fail to cultivate civilized qualities and respond to civilized motives. Hence, my talk to-day will bear, rather, on "the indispensability of civilization for the future of science." I shall invite your consideration of certain relationships between human nature, both individual and collective, on the one hand, and science on the other, and I shall illustrate some of these relationships with particular reference to geology and geography.

During their careers scientists acquire by bitter and sweet experience considerable information—even wisdom—concerning the influence of human nature on science. This they pass on to younger colleagues, who now and then give heed to it. Perhaps more heed would be given if the information itself were more "scientific." Actually most of it is gained hit or miss. Scrappy, unorganized and unsystematic, it breeds "pet theories."

The question of how human nature affects science is surely important enough to warrant a less personal and more systematic approach. Large quantities of data on the subject are available in published and unpublished documents relating to the history of science. From analysis of these data principles could be derived and illustrative examples could be drawn that would offend no one, as well might the use of examples taken from contemporary observation. Indeed, among the most valuable of the lessons to be learned from the history of science are those concerning the ways in

[1] Address of the retiring vice-president and chairman of the Section (E) on Geology and Geography of the American Association for the Advancement of Science (1943), Cleveland, September 13, 1944.

which science has hitherto reflected human nature and will doubtless always continue so to reflect it.

A Scientists' Macchiavelli

Macchiavelli wrote a manual for aspiring rulers of men. On the basis of research in history and in the biographies of persons who had succeeded or failed in the art of government, he composed his famous "Prince." I have in mind a sort of Macchiavelli's "Prince" for scientists—a manual that would analyze and synthesize those factors in human nature that contribute to success or to failure in the advancement of science. This manual, however, would not be "Macchiavellian" in its moral tone. It would deal with factors that contribute to the advancement of science rather than to the advancement of the scientist—not an unimportant distinction. Its writer, moreover, would have to pursue his biographical studies beyond the published "lives" of scientists, which deal largely with the successes of those who have been successful. Princes who fail create political havoc and hence their shortcomings are fully recorded. The shortcomings of men of science are more likely to be forgotten, though they may cause as much scientific havoc.

Let us assume that such a manual has actually been written by a Dr. Smith (a name which has no Macchiavellian connotations), that its title is "Smith's Manual for Scientists," and that the remainder of this address is a discussion of this imaginary work.

Like any good general introductory text-book in geology or geography Dr. Smith's book proceeds from the elementary to the more complex. Part I analyzes the several personal qualities that influence scientific research, somewhat as minerals and rocks are considered at the beginning of a geological text; Part II surveys the motives for scientific research, along lines comparable to the treatment of geologic processes—tectonic, erosional, etc.—; and Part III discusses scientific ideas much as formations of different periods are considered toward the close of the geological text.

Personal Qualities

The personal qualities discussed in Part I include judgment, common sense, honesty, diligence, energy, modesty, taste, intellectual curiosity, and many others, and also their opposites, which Smith calls anti-scientific qualities. Four qualities are stressed as having an especial bearing on science: originality, open-mindedness, precision and scientific consciousness.

Originality, with which are linked imaginativeness, creativeness, and the like, shows itself in the urge and the ability to find new fields of investigation, to invent new techniques of research and exposition and to devise new hypotheses. It provides the dynamic personal driving force in the advancement of science. The other three qualities provide governing controls that keep originality from running wild. As long as originality is held on the track, a man of science could scarcely have it in excess, whereas too much open-mindedness or too much precision may be as anti-scientific in their effects as too little.

Open-mindedness, to which critical acumen is closely related, is the disposition to give full consideration to all the evidence and to all reasonable hypotheses that bear on any problem. Excess of open-mindedness may inhibit the scientist from adopting any hypothesis at all; it may lead him to see so many sides of a problem that he fails to espouse any one, contenting himself with "impartially presenting the facts and leaving it to the reader to interpret them." This is a not uncommon weakness, especially in the social studies today, where the facts are bafflingly complex. Dr. Smith hazards the opinion that excessive open-mindedness explains why the output of a good many geographers has been primarily descriptive rather than explanatory or interpretative, and that geologists as a group are freer from this failing. Not being a geologist I don't know whether he is correct in this. Closed-mindedness, he maintains, is a more definite anti-scientific quality. It shows itself in violent denunciations of hypotheses, or sometimes even in unwillingness to recognize data that contradict a pet theory. When combined with originality, energy and vanity, closed-mindedness has been known to produce fanatical devotion to pet theories—especially when they are a scientist's own beloved brain children.

Precision, with its little sister accuracy, is as necessary a quality in a scientist as is sharpness in an edged tool. There is no excuse for inaccuracy that springs from sheer carelessness, and Smith advises well-meaning but "congenitally inaccurate" persons to avoid scientific pursuits. They do not always do so. There can, however, be too much precision. One does not cut down forests with razors, and, similarly, degrees of precision are often possible that may far exceed what is needed for a specific task in hand. Striving to attain such super-accuracy yields diminishing returns by reducing production without commensurate improvement in quality. Fussy and over-meticulous men of science do less for science than those who know just where to call a halt to their perfectionist inclinations. Excessive zeal for precision has delayed the publication of the results of researches until after the date when they would be of greatest use.

A scientific investigator might possess all the foregoing desirable qualities and yet be subject to the influence of undesirable motives. The fourth essential quality, therefore, is ability to discriminate between motives. This quality is "scientific consciousness" or the possession of a scientific conscience, which Dr.

Smith maintains is merely a special aspect of social conscience.

MOTIVES

To do justice to the very broad and important subject of motives, which is taken up in Part II, Dr. Smith concedes is a task that could be adequately performed only by an exceedingly wise man—a combination of scientist, historian and philosopher. He ventures into this field with some trepidation, which I confess to sharing with him.

He cites Webster's definition of "motive" as "that which incites to action." Every motive is either pro-scientific, anti-scientific or non-scientific, depending upon whether it promotes, retards or exerts no effect on the advancement of science. Every motive, moreover, is either a personal, a group or a disinterested motive, depending on whether it springs from a desire to serve individual interests, group interests or the interests of no particular individuals or groups. Dr. Smith illustrates these kinds of motives as they might operate concurrently in the case of a volcanologist in studying an active volcano. Curiosity as to how the volcano works and the desire to make some money in doing field work on its slopes are personal motives; an impulse to discover facts that might benefit the villagers living near the volcano and a wish to collaborate in a research program of a volcanological institution would constitute group motives; a desire to add to the general fund of scientific knowledge of volcanoes would constitute a disinterested motive. These are all pro-scientific motives. Anti-scientific motives would be exemplified in the volcanologist's fear of collaborating with a colleague lest the latter might steal some of his ideas, or in the cruder fear that might cause him to throw away his notebook and camera in his hurry to get away from an eruption.

PERSONAL MOTIVES

As regards personal motives, Smith does not dwell on that of making money, since this motive is in no way distinctive of scientists, and his subject is motives as they affect science itself rather than as they affect the fortunes of those who profess it. He does, however, analyze with considerable care the motives that spring from two personal desires—the desire to satisfy intellectual curiosity and the desire to be well thought of.

INTELLECTUAL CURIOSITY

Cats, he says, feel an absorbing curiosity regarding mice. While they are lured by scents and signs that indicate the proximity of the latter, they are immune to the allurement of dogs. So also, different scientists are susceptible to different allurements. Geographers are responsive to what they call the lure of place and the lure of the map.

The lure of place is an attraction that localities exert on the imagination—a curiosity concerning the nature of things as they exist in different places and regions. The lure of the map is the attraction of the shapes, forms and arrangement of things on the earth's surface, a geometrical curiosity concerning concepts that are, or might be, shown on maps. The lure of place Smith compares with the musician's sensitivity to tone or the painter's to color; that of the map with the musician's feeling for rhythm or the painter's for design. The "born geographer," if such there be, derives personal satisfaction from responding to these lures, just as the chemist derives personal satisfaction of a different sort from responding to chemical lures to which the geographer is indifferent. Dr. Smith's analysis of the psychological nature of the various scientific allurements makes an interesting digression.

We are more concerned here with his discussion of the controls that scientific conscience exerts upon the motives of satisfying intellectual curiosity. A well-developed scientific conscience, he argues, vetoes the waste of time, energy and talent upon studies that satisfy curiosity but do little more besides. Care in the accumulation of data, brilliance in their comprehension and exposition, and ingenuity in the development of theories are to little purpose if the facts and theories are of meager concern to anybody but the man who gathers and expounds them. A geographer might be impelled by a burning desire to make an intensive study of a very small area, when some one else has already made a similar study of a similar area in the same region. If the geographer has a scientific conscience it will warn him against yielding to this temptation unless he is firmly convinced that something new and of substantial value to others than himself will come from his study. To add embroidery to concepts and principles already well established may be enjoyable, but a scientific conscience warns against doing so when there are more pressing needs for other types of geographical research. Of course, Smith admits, it sometimes happens that an investigation which seems utterly useless at the time it is made, later turns out to be of far-reaching value, but he feels that the slight probability of this occurring must be weighed against the more obvious social needs for the services of scientists and against the fact that there are none too many scientists to meet such needs.

THE DESIRE FOR GOOD REPUTE

Scientists, he goes on to point out, are not unlike other mortals in their desire to be thought well of and their motives are strongly influenced by the opinions of others. Scientific conscience tells the scientist which opinions to heed and which to reject. There have been

times when it demands resistance to the opinions of persons who have it in their power to ruin a scientist's career or even to take his life, and science, like religion, has had its martyrs.

Smith shows that opinions or judgments of the relative worth of scientific investigations are of three main kinds: "formal" opinions, based on criteria of form and substance; "qualitative" opinions, based on criteria of scientific quality; and "pragmatic" opinions, based on criteria of effectiveness. As an example he asks us to suppose that three scientists are asked to express views as to whether or not two books should be published. The first book is a treatise on contemporary geopolitics, carelessly written, poorly arranged and wholly unsound in its reasoning. The second book deals with the historical geography of ancient Siam; written in a beautiful style, it is based on profound erudition and is thoroughly convincing in its handling of all the available evidence. Scientist A says: "Publish the first book since geopolitics is more vital than historical geography." This would be a formal judgment. Scientist B says: "Publish the second book because it is so much better in quality," clearly a qualitative judgment. Scientist C says: "Don't publish either, since neither will exert much influence, the first because it is so bad, the second because it is so recondite." This is a pragmatic judgment.

Formal Opinions

Dr. Smith comments on the propensity of certain men of science to express sweeping judgments of whole fields and whole methods of scientific investigation. While these judgments are often penetrating in their insight and exert a beneficial effect, sometimes, on the other hand, they reveal a distinctly lower order of scientific thought than would normally be used by those who propound them in their own specific researches. When such opinions crystallize into widely and uncritically accepted clichés Smith believes they may be harmful, and that they are likely to be particularly harmful when based primarily on formal rather than primarily on qualitative or pragmatic criteria.

Among such clichés founded primarily on formal criteria he cites the view that experimental research and first-hand studies in the field are inherently more "scientific" than researches in libraries; also the opinion that quantitative studies yield more genuinely scientific results than those in which quantitative measurements are not feasible. Another formal cliché judgment, he says, is unconsciously expressed when certain works are damned with faint praise as "mere description," "nothing more than compilation," "simply a matter of techniques."

Science is founded on the assumption that the universe is governed by laws, and the goal of science is to discover and formulate these laws. Dr. Smith, however, with some justification, regards as a cliché the rating of those forms of scientific investigation which yield precise and reliable statements of laws as necessarily more scientific than those which do not. Some of the laws of astronomy have been formulated so accurately that eclipses may be predicted thousands of years hence. The laws of economics barely permit the prediction of what is going to happen next week. But to regard astronomy as therefore more worthy of scientific respect than economics, Smith believes, is to take a narrow, formalistic view of the scope and nature of science.

Geographers may be interested in what Dr. Smith says about certain formal clichés concerning their subject, though not all of them will agree with him. Not so long ago, he points out, geography as a whole was criticized because a number of geographers were prone to give unlimited scope to their imaginations in the matter of generalization. The whole discipline was condemned for the excesses of some of its devotees. This helped instil in certain other geographers a horror of generalization and reluctance to generalize. In other words, these latter geographers adopted a formal cliché about the nature of generalization. Rather than take risks of generalizing, they turned to "safe" quantitative studies, to microgeographical researches and to emphasis on the accumulation rather than on the interpretation of facts. This, in turn, gave rise to yet another formal cliché on the part of non-geographers, that geographers are sterile in ideas and narrow in vision.

Since the whole purpose of science is to establish general principles, an irrational fear of generalization *per se* is anti-scientific. What is to be shunned is unsound generalization. Similarly microgeography *per se* is not necessarily narrow and without vision—only microgeography that yields little larger fruit. But when generalization is condemned for unsoundness the judgment is qualitative, not formal, and when microgeography is condemned for leading nowhere the judgment is pragmatic—not formal. Dr. Smith shows, however, that judgments in which little or no account is taken of quality or effects are easily and often made.

Qualitative Opinions

That qualitative judgments of the worth of scientific investigations are fairer than formal judgments, Smith holds to be obvious. A qualitative judgment takes account of the degree of good sense, originality, accuracy, open-mindedness, and so forth, to which a study bears witness. It also takes account of the suitability of the form and substance to the solution of the problem in hand. Thus field studies would be rated

higher in quality than library researches only in cases where better evidence can be secured by the former than by the latter. While field observations provide the primary data for geology and geography alike, it would be ridiculous for a geologist or geographer to expect that he could solve many of the larger problems that confront him, problems involving synthesis and correlation, by investigating them in the field alone.

While the goals of science are the discovery and formulation of laws, a lot of work has to be done before laws can be formulated, and this preliminary work, in Smith's opinion, is quite as indispensable, quite as "scientific," as are the subsequent processes of interpretation to which it leads. Part of the preliminary work consists in "mere" compilation, description and development of techniques. Qualitatively such procedures, as long as exacting, critical and original scholarship is devoted to them, rate higher than speculative attempts to establish laws on the basis of faulty reasoning from insufficient evidence. To Dr. Smith an economic law is fully as scientific as is the law of eclipses, provided all available evidence is used in developing the economic law and used with the same degree of rationality as that attained in developing the astronomic law. That the actual probability of the economic law is less he regards as immaterial to its scientific quality.

Whole broad domains of science are cultivated not for the immediate purpose of formulating general laws but in order to understand specific conditions and processes. This is especially true of geology and geography, where the first objective is to explain the origins, nature and relationships of particular land forms, rock formations, types of settlement, routes of trade, and what not, as they exist in particular regions. These studies prepare the way for the formulation of geological and geographic laws sometime in the future, but the way may be long. If the scientific merits of research are judged formally according to the degree to which they succeed in stating general laws, rather than according to the quality of the work devoted to such research, a large part of our two sciences of geology and geography would be denied scientific merit—something that we may unite with Dr. Smith in regarding as absurd.

Pragmatic Opinions

Pragmatic opinions, as distinguished from formal and qualitative opinions, are those which rate scientific researches in terms of their effects. While it is usually true that the better the quality, the better are the effects, this is not invariably so. Smith shows that incomplete and even careless studies of little understood but important phenomena may exert more far-reaching and more beneficial effects than studies of higher quality that deal either with inconsequential matters or matters already well understood in their essentials. Great works of compilation often rate extremely high from the pragmatic point of view because of the innumerable practical purposes that they serve and because they furnish the stimulus for the development of scientific theories. Even "outrageous hypotheses," as the late Professor W. M. Davis pointed out, may have pragmatic worth by providing means of testing the validity of other hypotheses.

The pragmatic opinions that others hold of the effectiveness of his work are largely instrumental in fashioning the nature of a scientist's response to *group* motives. This subject Smith takes up in the next chapter.

Group Motives

Here he states that science is the product of human gregariousness and that it would be hard to conceive of a scientific investigation not motivated in part at least by a desire to serve the interests of some group of people—be it an organized group, such as a university, a society, a community, a corporation, a nation, or largely unorganized, such as the geological or the geographical professions, or the people who happen to dwell on the slopes of a volcano, be it actual or figurative. But while this desire, combined with personal curiosity, has brought science into being, certain group motives have also constituted serious obstacles to the advancement of science, and it is with these anti-scientific motives that Dr. Smith is most concerned.

Anti-scientific group motives spring from competition and conflict among groups—from the ambition of groups to get the better of one another and from their fear of being got the better of. These conflicts, moreover, are on many levels: they range from quarrels between or within departments in a single university to world wars between coalitions of nations. They give rise to three types of anti-scientific practice: the wilful distortion of truth in order to mislead rival groups; the suppression of the results of scientific research in order that rivals may not benefit by them; and the use of the results of scientific research to injure rival groups.

That the first of these practices—the distortion of truth—is the negation of science is self-evident, but that the second and third are anti-scientific Dr. Smith believes to be less obvious. It has been argued that science is advanced whenever scientific research is conducted whether or not the results are suppressed, and that the use of the results is of no scientific concern—in other words that these are questions of morals and not of science. Dr. Smith, however, seeks to demonstrate that ethics and science are inextric-

ably linked and that unethical practices are not only anti-social but anti-scientific.

He argues that the advancement of science demands the continuous discovery of new truths and the continuous development of new hypotheses. For this the fullest and freest possible interchange of knowledge already acquired is prerequisite and anything that hinders this interchange retards the advancement of science. Indeed, the very word "science" connotes something that can not be hoarded in secrecy. While one says "my knowledge" or "the government's knowledge," one never says "my science" or "the government's science." Science, unlike knowledge, is indivisible in the sense that no part of it can be the exclusive possession of an individual or a group and the whole of it is the common property of humanity. When we make a "contribution to science," we donate some of our knowledge to humanity. Knowledge may be scientific in quality, but as long as it is kept locked in files marked "secret," "confidential" or "restricted," it remains mere knowledge. It does not become science until it is made at least potentially available to any one who wishes to use it.

Much scientific research has been conducted for the express purpose of applying its results to the injury of other groups. Wars have produced such feverish bursts of scientific activity and have so greatly accelerated certain discoveries and inventions that it has even been maintained by some that war has accomplished more than has peace to promote the advancement of science. Smith emphatically rejects this doctrine. That human enlightenment in the long run can have benefited more than it has suffered from group selfishness, conflict and fear he regards as an "outrageous hypothesis" of no pragmatic value.

Disinterested Motives

The last chapter of Part II of Smith's manual deals with disinterested motives in science. These are the incentives to scientific endeavor, which, because they do not spring from the needs or interests of specific individuals or groups, are necessarily incentives to serve the general needs of humanity.

Scientific work is never motivated solely by disinterested purposes—never without any trace of the influence of desires to serve personal or group interests. Disinterested motives operate concurrently with rather than to the exclusion of group and personal motives, and one of their principal functions is to counteract or nullify the anti-scientific influences of selfish and destructive group motives. By inciting men of science to resist anti-scientific and anti-social practices disinterested motives operate, Dr. Smith says, somewhat as do the preservatives put in foods to prevent their spoiling. They have, however, a more positive function—that of inspiring men of science actively to seek out those lines of endeavor that will be of service to mankind.

Science and War

We come now to Part III of Smith's manual, which deals with the nature of certain larger problems in science in the light of the various qualities and motives analyzed in the two preceding parts. Time does not permit me to dwell here on more than two of these problems—those of the effects of war upon science and of the reconstruction of scientific endeavor after the war.

While he regards the institution of war as detrimental to the advancement of science in the long run, he is far from regarding war as an unmitigated evil in its effects upon science. War gives complete priority to a particular group motive—that of helping one's nation to win. In wartime all other motives —personal, group and disinterested—are overshadowed by this one, which produces an intensity of thought, a passion for hard work and a collaborative spirit among scientists that are seldom equalled in peacetime. It also leads to rapid advances along certain specific lines of research. This is the bright side of the picture. The darker side is that scientific effort as a whole is regimented and hence distorted. In times of peace the pioneer fringe of scientific knowledge advances more or less evenly along a broad front and in the open, where all who wish to look can see its advance. In war long stringy arms shoot ahead into the unknown, while large segments of the frontier remain at a standstill and many of the most rapidly advancing arms are blotted out by clouds of censorship. The operation of disinterested motives is not only weakened but often entirely prevented.

Dr. Smith makes it clear that the problems that a nation faces in getting into and in getting out of a war are often more difficult of solution than those of actually waging the war itself and that this is true no less in the realm of science than in other realms of national life. While a war is in progress, much scientific work can proceed smoothly "according to plan." The most serious difficulties are encountered in making the transitions from peace to war and *vice versa*. Smith believes that it is none too soon for American scientists to give thought to the readjustment that they will have to make when the compulsions and the restraints of wartime are removed.

As a car must be refitted in the spring for warm-weather driving, so the machinery and organization of scientific investigation will require reconditioning for peacetime operation. For one thing, steps will

have to be taken to reestablish the fellowship of men of science throughout the world—a fellowship in which the nationalistic impulses of aggression, fear and suspicion can be made partly if not wholly subordinate to the disinterested service of science. Within each nation anti-scientific restraints—censorship and censoriousness, in particular—must be abolished with the utmost possible dispatch. In this reconditioning of scientific endeavor, the benefits of its wartime operation must be preserved in so far as possible, especially the spirit and means of collaboration that the war has developed. The artificial academic barriers that this collaboration has done so much to break down must not be permitted to arise again. Men of science must make concerted efforts to forestall the loss or destruction of the masses of information that have been accumulated in government offices and elsewhere for wartime purposes. Peace will bring a widespread let-down, an inertia that will have to be overcome if this latent science—as it might be called—is to be saved and released promptly for use.

Imperative as will be this reconditioning, it is merely a means to an end. Just as the end in the case of the automobile is to drive it somewhere, so in the case of scientific research it is the production of needed types of science, and the larger problem is what the mechansims of scientific research shall be made to produce when peace returns.

Some might say that it should not be *made* to produce anything in particular—that compulsion stifles originality and initiative, and that scientists should be free to study whatever they please in whatsoever manner they wish. Dr. Smith thinks there is wisdom in this view, provided one important qualification is made. While freedom of science is fundamental, like freedom of speech it is a freedom that imposes responsibilities. It is freedom to investigate whatever one wishes, subject to the dictates of scientific conscience. A developed and enlightened scientific conscience will always incite its possessor to select from among the innumerable subjects by which he is attracted in his chosen field, those in which his abilities can best be employed toward meeting the greatest human needs.

Along with many other contemporary observers, Smith maintains that science has given men a mastery over nature so extensive and so skilful that, if uncontrolled, it may lead, not to making the world more civilized, but to the destruction of civilization itself. This will happen unless an equal degree of mastery can be achieved over the forces, both good and evil, in human nature. Hence Dr. Smith believes that the most urgently needed of all forms of science is that which will contribute to increasing the will and the power of human groups to collaborate with one another instead of cutting each other's throats. The development of this will and this power has traditionally been considered a task for experts in morals rather than for men of science. Good motives, however, whether on the part of an individual or a group, can not be inculcated by moral precepts alone. A child is more likely to behave if given a rational—a scientific, in other words—explanation of the undesirability of ill behavior, than if merely told that such and such conduct is bad. The child ordinarily misbehaves because he feels injured or thwarted, not because of the machinations of Satan or the promptings of original sin. Similarly groups cut each other's throats because they feel, rightly or wrongly, that they are thwarted or imposed upon by other groups possessing greater advantages. Science can often disclose whether such sentiments are founded on fact or fancy, and if they are founded on fact, science can seek for and test out measures of amelioration.

Many of the largest and toughest roots of man's inhumanity to man are embedded in the circumstance that certain groups enjoy advantages over others because they occupy or control particular areas of the earth's surface. There are inter-areal conflicts within every village, every state and every nation, and, worst of all, between nations. Neighbors quarrel over fence lines and wandering cattle; nations fight over boundaries and the control of vast territories. Hence, those branches of science which deal with areas, their occupants and those who control them in terms of their relative advantages and disadvantages can do much to lay bare the roots of human conflict—and the laying bare of roots is a necessary preliminary to their removal. Areal, or regional, research lies partly within the provinces of geology and geography. Hence Dr. Smith believes that our two sciences afford immense potentialities of service to perplexed humanity and that geologists and geographers are in a peculiarly favorable position to produce scientific fruit indispensable for the future of civilization.

OBITUARY

A. H. REGINALD BULLER

A. H. REGINALD BULLER, emeritus professor of botany at the University of Manitoba, Canada, died in Winnipeg on July 3, 1944, after an illness lasting five months. He was nearing the end of his seventieth year.

Long familiar as an enthusiastic and energetic participant in meetings of scientific societies on both sides of the Atlantic, his passing robs the science of botany of one of its most illustrious and colorful figures. In the multiple role of research worker, teacher and public speaker, he possessed a breadth of vision all too rare in our time and an infectious enthusiasm that pervaded his whole life work.

Born in Birmingham, England, in 1874, Dr. Buller received his early education at Queen's College, Taunton. From Taunton he went to Mason College, Birmingham—now the University of Birmingham—and studied for the University of London examinations. When he received the B.Sc. degree from the University of London, he was awarded the Heslop Gold Medal from Mason College.

In 1898, the young student won the "1851 Exhibition Scholarship" which enabled him to proceed to the universities at Leipzig and Munich; from the former university he obtained the doctorate of philosophy. In Germany he came under the influence of such stalwarts of botany as Pfeffer, Strasburger and Hartig. From these great minds he learned the meticulous devotion to detail and the principle of studying the living organism as far as possible under natural conditions, which were later to be among the most valuable characteristics of his own researches and his teaching. His studies of forest pathology published during this period marked clearly the course of a lifetime devoted to the study of fungi in which physiology, natural function and relation to other living organisms were the problems uppermost in his mind.

After leaving Germany, he spent one year at the International Marine Biological Station at Naples, where he studied the fertilization of the eggs of sea urchins. This interest in the sister science of zoology was never lost, and he frequently astonished his students by a lucid explanation of some subject in zoology with which they hardly expected him to be familiar.

In 1901, he was appointed lecturer in botany at the University of Birmingham, and there he began in earnest the mycological research which resulted in the publication of his "Researches on Fungi," of which six volumes are as well known to students of mycology as Brefeld's "Untersuchungen." Until a short time before the onset of his fatal illness, he was still pouring out the results of his studies on the Rust Fungi in manuscript and drawings intended for additional volumes.

Dr. Buller was called in 1904 to the University of Manitoba, where he founded the department of botany and remained its head until his retirement in 1936.

Others will no doubt review in detail and appraise the great volume of publication which early won him recognition. In addition to the "Researches on Fungi," his publications included "Essays on Wheat" (1919) and "Practical Botany" (1929).

He collaborated with Drs. G. R. Bisby and John Dearness in the preparation of "The Fungi of Manitoba" (1929), and later with those authors, and with the late Dr. W. P. Fraser and Dr. R. C. Russell in the expanded book, "The Fungi of Manitoba and Saskatchewan" (1938). He acted as co-editor with Dr. C. L. Shear of W. B. Grove's translation of the "Selecta Fungorum Carpologia" of the brothers Tulasne (1931) and was largely responsible for the publication of this great work. This undertaking was very important to him. He constantly emphasized to his students the necessity of knowing thoroughly the classic literature of their science and realized the value of making available in inexpensive form a classic which was formerly to be found in but a few large mycological libraries.

In the form of a very large number of separate articles, Dr. Buller's mycological writings appeared in almost all the well-known botanical journals. At first concerned chiefly with spore discharge and sexual phenomena in the higher Basidiomycetes, they eventually contributed to a wide range of mycological topics.

Buller's vigorous action regarding the epidemics of stem rust of wheat in Western Canada during the first World War was in no small part responsible for the establishment of the Dominion Rust Research Laboratory in Winnipeg. The men of vision, like Buller, who urged the necessity of fundamental research into the problems of the great rust epidemics of those years must be remembered with gratitude when the successful outcome of these studies is contemplated.

Part of the genius of this man was his diversity of interests. His first love was mycology, but he was at all times a most able botanist in a general sense, as was shown by his first-class knowledge of and interest in both European and Canadian plants. His interest in ornithology and geology was not perfunctory. In fact, there was scarcely a field of science in which he did not interest himself. Shortly after his retirement, he set himself a serious course of study of the newest ideas in physics and chemistry. He tried to understand and was prepared to accept the newer ideas so radical when compared with what was taught in his own student days.

A strongly developed artistic sense manifested itself in his love of nature, of sculpture, of poetry and of music. His library contained many volumes of the best poetry and prose, and one of the last entries in his diary records his pleasure in reading

Milton. His own efforts at versification were the delight of his friends whom he regaled with whimsical poems on scientific subjects and with his beloved limericks of which he had a unique collection.

He found time to enjoy social contacts and retained a picturesque Victorian manner in conversation. Children delighted him and he would often entertain the young folk at the homes of his friends with sleight-of-hand and puzzles.

Dr. Buller's lectures to the public as well as to his own students will long be remembered for the high degree of interest aroused through his almost amusing enthusiasm, and for the rare lucidity of presentation. Those who worked with him learned at least part of the secret of his success in this regard: nothing was too much trouble to him that could possibly serve to illustrate his points. He spent countless hours in the preparation of lectures and threw himself into the task of delivering them with all the energy and resource at his command.

A list of the honors conferred upon him is a significant, even if prosaic, testimony of his recognition. In 1927 he was elected to the fellowship of the Royal Society (London), the first resident of Western Canada to be so honored. The following list includes other honors which came his way:

President of the British Mycological Society, 1913; president of Section IV, Royal Society of Canada, 1914–15; president of the Canadian Phytopathological Society, 1920; president of the Mycological Section of the American Botanical Society, 1921; associate member of the Société Royale de Botanique de Belgique, 1921; Hon. LL.D., University of Manitoba, 1924; Norman Wait Harris Foundation lecturer at Northwestern University, 1927; president of the Botanical Society of America, 1928; president of the Royal Society of Canada, 1927–28; Hon. LL.D., University of Saskatchewan, 1928; Flavelle Medal of the Royal Society of Canada, 1929; Hon. D.Sc., University of Pennsylvania, 1933; corresponding member of the Netherlands Botanical Society, 1935; president of the Section for Mycology and Bacteriology, Sixth International Botanical Congress (Amsterdam), 1935; vice-president of the Mycological Society of America, 1936; Medal of the Manitoba Natural History Society, 1936; Royal Medal of the Royal Society, 1937; delegate of the British Association, Calcutta, 1937; Hon. D.L., University of Calcutta, 1937; visiting professor of botany at the Louisiana State University, 1941; Hitchcock visiting professor of botany of the University of California, 1942; Schiff Foundation lecturer at Cornell University, 1942.

Among his colleagues everywhere Dr. Buller will be remembered as a scientist of extraordinary scientific acumen and integrity. Principal R. C. Wallace, of Queen's University, said of him, "He was the most intellectually and scientifically honest man I ever knew."

Dr. Buller is survived by one sister, Mrs. H. B. Workman, Wimbledon Park, London, and a cousin, Miss Ella Buller, Banbury, England.

HAROLD J. BRODIE
C. W. LOWE

DEPARTMENT OF BOTANY,
UNIVERSITY OF MANITOBA

RECENT DEATHS

DR. JOSEPH MARSHALL FLINT, from 1907 to 1919 professor of surgery at the School of Medicine of Yale University, previously for six years professor of anatomy at the University of California, died on September 16 at the age of seventy-two years.

CHARLES FRANCIS PARK, emeritus professor of mechanical engineering at the Massachusetts Institute of Technology, director of the Lowell Institute School, died on September 25 at the age of seventy-five years.

DR. EUGENE LERNER, professor of psychology at Sarah Lawrence College in Bronxville, N. Y., died on September 1 at the age of forty-three years.

DR. ISRAEL J. KLIGLER, who held the Jacob Epstein chair of bacteriology and hygiene at the Hebrew University at Jerusalem, died on September 23 at the age of fifty-five years.

SIR HUMPHRY DAVY ROLLESTON, who was Regius professor of physic at the University of Cambridge from 1925 to 1932, past president of the Royal College of Physicians, London, died on September 25 at the age of eighty-two years.

SCIENTIFIC EVENTS

THE NATIONAL FOUNDATION FOR INFANTILE PARALYSIS

IN the last eleven years the American people have contributed $29,562,742 to conquer infantile paralysis, according to the report of Dr. Basil O'Connor, president of the National Foundation for Infantile Paralysis, presented at the annual meeting on September 11 of the medical advisory committees of the foundation. At that meeting applications for grants to carry on medical research were considered and further plans were made.

This money was raised through the celebration of President Roosevelt's Birthday and the March of Dimes, held in January of each year, beginning with

1934. Sixteen million dollars, or more than half the amount, was raised in 1943 and 1944. The increase was probably due in part to the high incidence of the disease. Since the National Foundation was organized six years ago, it has made two hundred and ninety-eight grants to seventy-four institutions involving a hundred and fourteen groups of workers. During the past eleven years almost $15,000,000 of the amount collected has been left with the counties where raised to provide medical care for the thousands of new patients reported each year. This averages about $444 per county per year, and $160 for each new case reported during that period.

Of the balance of nearly thirty million dollars, the sum of approximately thirteen million dollars has been appropriated as follows: virus research, $2,053,761; after-effects research, $1,405,292; education, $1,179,215; epidemics, $637,548; Tuskegee Institute, $404,256; Georgia Warm Springs Foundation, $825,000—total $6,508,475.

From the first four celebrations of the President's birthday, which occurred prior to the establishment of the National Foundation, the sum of $3,364,217 was realized. Of this sum $1,655,825 remained in the counties to provide for medical care; $1,467,392 was given to the Georgia Warm Springs Foundation, for which the birthday celebrations were originally initiated, and $241,000 to a commission to be used for scientific research.

It is estimated that the National Foundation and its chapters have expended more than a million dollars up to September 1 on the 1944 epidemic alone. In addition there will be the necessity of caring for many of its victims in years to come, while continuing the care for those of former years.

MELLON INSTITUTE TECHNOCHEMICAL LECTURES

A SERIES of lectures on keeping up with chemical technology will be presented by specialists of Mellon Institute of Industrial Research during 1944–45. These discourses, which will be delivered on Wednesdays from 11:40 A.M.–12:30 P.M. throughout both semesters in the auditorium of the institute, will be open to all students in the professional courses in chemical engineering and chemistry in the University of Pittsburgh, as well as to members of the institute.

1944

October 11, Dr. E. W. Tillotson, Economic Aspects of the Chemical Industries
October 18, Dr. W. A. Gruse, Advances in Petroleum Technology
November 1, Dr. R. W. Miller, Developments in the Gas Industry
November 15, Dr. H. J. Read, Progress in the Electrochemical Field
November 22, Dr. L. A. Carapella, Light Metals and Alloys
December 6, Dr. H. L. Anthony, Welding and Brazing of Pressure Vessels
December 13, G. W. Seagren, Protective Coatings

1945

January 10, Dr. W. H. Hill, Coal Distillation
January 17, Dr. R. L. Wakeman, The Newer Plastics
February 21, Dr. B. B. Corson, Industrial Catalysis
March 7, Dr. L. T. Sandborn, Utilization of Wood Constituents
March 21, R. G. Ruark, Corn Products
April 4, Dr. R. J. Sumner, Wheat Products
April 18, Dr. G. E. Helz, Food Packing Industry
May 2, Dr. T. H. Swan, Advances in Textile Technology
May 16, W. C. L. Hemeon, Industrial Hygiene

CHICAGO MEETING OF MATHEMATICIANS

THE American Mathematical Society and the Mathematical Association of America will hold meetings in Chicago from November 24 to 26, inclusive. The sessions will be held at the Museum of Science and Industry. The sessions of the American Mathematical Society will open on Friday morning and continue through Saturday afternoon. Professor Will Feller will deliver an address by invitation on "Limit Theorems in the Theory of Probability." On Friday evening the Josiah Willard Gibbs Lecture will be given by Professor John von Neumann on "The Ergodic Theorem and Statistical Mechanics."

The Mathematical Association will hold its meetings on Saturday evening and Sunday morning. The complete program will be mailed early in November to all members of the association, and to any non-members who send a request to the Secretary, at McGraw Hall, Cornell University, Ithaca, New York.

Hotel headquarters will be at the Hotel Windermere, 1642 East 56th Street. Due to the influx of visitors on war business, there is a scarcity of hotel space in Chicago and members are urged to make reservations well in advance. They should be made directly with the hotel concerned.

AWARD OF THE PERKIN MEDAL

THE Perkin Medal of the American Section of the Society of Chemical Industry has been awarded to Dr. Elmer K. Bolton, chemical director of E. I. du Pont de Nemours and Company, Wilmington, Del., "in recognition of his outstanding accomplishments in the field of industrial research." Presentation of the medal will be made at a dinner meeting of the society at the Commodore Hotel, New York City, on January 5. The official announcement of the award reads in part:

Dr. Bolton will be the thirty-ninth member of the group of distinguished chemists to receive this medal. He was also awarded the Sheldon Fellowship from Harvard, and under this fellowship did post-doctorate research at the Kaiser Wilhelm Institut für Chemie, in Berlin. Here in the laboratory of Professor Richard Willstätter he isolated and established the chemical constitution of the pigments of geraniums, scarlet sage and dark red chrysanthemums.

His undertaking in 1925 of a search for a practical synthetic rubber, in spite of previous repeated failures, emphasizes his vision and boldness as a research director. Through his persistent stimulation and guidance, this search culminated in the commercial manufacture of chloroprene synthetic rubber—commonly known as neoprene—which to-day is a key product in the national synthetic rubber program.

A broad program to explore the fundamentals of polymerization phenomena was undertaken by the Chemical Department in 1928 under the late Dr. Wallace H. Carothers. In the course of these studies synthetic polyamides were discovered, and under Dr. Bolton's direction the development of nylon as a new and revolutionary commercial textile fiber was brought to successful fruition.

In 1941, Dr. Bolton received the Chemical Industry Medal, which is awarded annually by the American Section of the Society of Chemical Industry, for "valuable application of chemical research to industry."

An informal reception for the medalist will be held at the Commodore Hotel immediately before the presentation dinner. Dr. Norman A. Shepard, of New York City, chairman of the American Section of the Society of Chemical Industry, will preside. The medal will be presented to Dr. Bolton by Dr. Marston T. Bogert, senior past president of the society.

SCIENTIFIC NOTES AND NEWS

DR. EDWARD B. KRUMBHAAR, professor of pathology in the School of Medicine and in the School of Graduate Medicine of the University of Pennsylvania, has been elected an honorary fellow of the Royal Society of Medicine, London, "in recognition of his distinguished services to science."

AT the Niagara-Buffalo meeting of the Electrochemical Society, which will be held on October 12, 13 and 14, the Acheson Medal and Prize of $1,000 will be presented to Dr. William Blum, of the National Bureau of Standards. On Friday there will be a reception in honor of Dr. Blum, which will be followed by the Acheson Medal Dinner, at which the speakers will be Sidney Dale Kirkpatrick, of the McGraw-Hill Publishing Company, president of the society; Professor Hiram S. Lukens, of the University of Pennsylvania; Thomas Slattery and Dr. Blum.

ALEX D. BAILEY, vice-president of the Commonwealth Edison Company, Chicago, has been elected president of the American Society of Mechanical Engineers.

L. M. K. BOELTER, professor of mechanical engineering and associate dean of the College of Engineering of the University of California at Berkeley, has been appointed dean of the College of Engineering of the University of California at Los Angeles, effective on November 1. The College of Engineering at Los Angeles was authorized in a bill passed by the last Legislature, which appropriated $300,000 to begin the work. No provisions were made for a building, since construction has not been possible, but an engineering building to cost $1,250,000 will be the first to be erected under the postwar construction plans of the university.

AT the Iowa State College the following appointments have been announced: head of the department of foods and nutrition, Dr. Ercel S. Eppright, of Texas College for Women; head of the department of institution management, Dr. Grace M. Augustine, of Texas College for Women; associate professor of foods and nutrition, Dr. Gladys Everson, of Wayne University; assistant professor of agricultural engineering, V. J. Morford, specialist in vocational education, the U. S. Office of Education. Dr. Pearl Swanson, professor of foods and nutrition at the college, in addition to her present position becomes assistant director of home economics research in the Agricultural Experiment Station.

DR. RICHARD H. GOODWIN, of the University of Rochester, has been made chairman of the department of botany and director of the Connecticut Arboretum at Connecticut College, New London. He succeeds Dr. George S. Avery, Jr., who resigned to become director of the Brooklyn Botanic Garden.

FOLLOWING the death of Dr. Edwin G. Woodward on July 7 from injuries received in the recent circus fire at Hartford, Conn., William L. Slate, director of the Connecticut Agricultural Experiment Station at New Haven, has been serving as acting director of the Agricultural College of the University of Connecticut at Storrs.

DR. JAMES O. BROWN has been appointed associate professor of anatomy and acting head of the department at the Woman's Medical College during the absence of Professor Hartwig Kuhlenbeck, who has been commissioned captain in the Medical Corps, Army of the United States.

DR. DWIGHT W. BENSEND has been appointed associate professor of forest measurements and utilization at the Utah State Agricultural College at Logan. Dr. Bensend was formerly instructor in forestry at the University of Minnesota, and more recently was engaged in research and instruction at the Forest Products Laboratory at Madison, Wis.

DR. JOHN W. ROSS has been appointed vice-dean for dentistry in the Graduate School of Medicine of the University of Pennsylvania. He will work in cooperation with the vice-deans for other medical studies under Dr. Robin C. Buerki, dean of the Graduate School, of which the scope has been enlarged to include graduate studies in dentistry.

DR. J. FISHER STANFIELD has been appointed professor of botany at Miami University, not of botany and bacteriology, as was reported recently. Dr. Orton K. Stark is professor of bacteriology in charge of the division of bacteriology of the department of botany and bacteriology.

DR. THOMAS FERGUSON, deputy chief medical officer of the Department of Health for Scotland, has been appointed to succeed Professor James M. Mackintosh as professor of public health in the University of Glasgow.

PROFESSOR LOUIS A. OLNEY, head of the department of chemistry and textile coloring of the Lowell Textile Institute, has retired with the title emeritus.

DR. JNO. A. FLEMING, general secretary of the American Geophysical Union of the National Research Council, announces the appointment of Waldo E. Smith to the newly created post of executive secretary of the union. Mr. Smith has recently been engaged on hydraulic engineering and hydrologic studies with the Public Roads Administration, Washington, D. C. He took up his new work on September 21.

DR. MERVIN J. KELLY, director of research of the Bell Telephone Laboratories, has been appointed to the newly established position of executive vice-president of the laboratories. Otto B. Blackwell, vice-president, has resigned to become assistant vice-president of the American Telephone and Telegraph Company.

DR. E. ARTHUR BEAVENS, bacteriologist of the Laboratory of Fruit and Vegetable Chemistry, Bureau of Agricultural and Industrial Chemistry at Los Angeles of the U. S. Department of Agriculture, has been appointed chemist in charge of the laboratory.

DR. WILLIAM A. LALANDE, JR., formerly director of research of Attapulgas Clay Company, has become director of the Research Division of the Pennsylvania Salt Manufacturing Company.

Nature reports that Dr. James Philp, who has been in charge of the cereal division of the plant breeding section of the Egyptian Ministry of Agriculture, has been appointed director of research for the South African Wattle Growers' Union, Pietermaritzburg. He is also acting in an advisory capacity to the Forestry Division of the South African Government, with which he was previously engaged as its first forest geneticist.

DR. KENNETH B. TURNER, on leave of absence from the College of Physicians and Surgeons of Columbia University, is directing the editing and publication of a weekly journal entitled *Summary of Reports Received by the Committee on Medical Research*, under the auspices of the Committee on Medical Research of the Office of Scientific Research and Development. Circulation of the publication is restricted to selected members of the Medical Corps in the United States, Canada and Great Britain.

PROFESSOR V. N. BUKIN, head of the Vitamin Laboratories of the Biochemical Institute of the Academy of Sciences of the USSR, is visiting the United States to make a study of vitamin research and production centers. He was recently guest of honor at a luncheon at the Hotel Pierre, New York, tendered by the Food Research Laboratories, Long Island City. Professor Bukin's headquarters are at the Government Purchasing Commission of the Soviet Union, 1610 Park Road, N.W., Washington, D. C.

IT is reported in the daily press that Dr. Paul Langevin, Nobel laureate in chemistry, until 1940, when he was dismissed by the Vichy Government, professor of physics at the Collège de France, has returned to Paris as director of the School of Physics and Chemistry.

AN all-day conference on the "Implications of Nutrition and Public Health in the Post War Period" will be held in the Horace Rackham Memorial Building in Detroit on Friday, November 3, under the auspices of the Research Laboratory of the Children's Fund of Michigan. The following topics will be discussed: "The International Implications of Freedom from Want of Food," by Dr. Frank G. Boudreau; "The Importance of Proteins in Resistance to Infection," by Dr. Paul R. Cannon; "Maintaining Dental Health," by Dr. Phillip C. Jeans; "Vitamins and the Health of the Nation," by Dr. Charles G. King; "Food Production for Better Health and Longer Life," by L. A. Maynard; "Our National Diet and Future Health," by Dr. E. V. McCollum; "The Role of Food Technology in Improving Nutrition," by Dr. Roy C. Newton; "Nutritional Reconditioning of Children in Occupied Countries," by Dr. Harold C. Stuart; "Research and Nutrition for Human Health," by Group Captain Fredrick F. Tisdall, Canada.

A POSTGRADUATE Assembly on Nervous and Mental Diseases, and War, sponsored by the Institute of Medicine of Chicago, will be held on November 1 and 2 in the Palmer House, and will be devoted to phases of neurology, psychiatry and neurosurgery that are of particular importance at this time. There will be five addresses on each of the two mornings and on one afternoon. A "Neuropsychiatric Information Please" program will be given on the first evening, with Dr. Foster Kennedy as moderator, and panel discussions on the afternoon of the second day. The seventeenth Pasteur Lecture of the Institute of Medicine of Chicago will be delivered on the second evening by Dr. Edward A. Strecker. Complete programs and registration cards can be secured by addressing the Institute of Medicine of Chicago, 86 Randolph Street, Chicago 1, Illinois.

The Experiment Station Record reports that, following a request of Dr. L. H. Bailey, the name of the Cornell University Arboretum has been changed to the Cornell Plantations. Dr. Bailey will serve as chairman of the policy committee to work out details for an enlargement of scope, whereby in addition to the usual plant collections there will be included all things that grow, animals as well as plants, the idea being to constitute an educational program designed to embody a whole series of enterprises based upon the land.

THE Ordnance Distinguished Service Award for outstanding contributions to ordnance progress during the course of the war has been given by the War Department to the Battelle Memorial Institute, Columbus, in recognition of scientific and engineering achievement.

THE *Journal* of the American Medical Association reports that a gold medal will be awarded annually by the Ophthalmological Society of Egypt for "the contribution deemed most valuable that year in the field of ophthalmology." A competitive essay will determine the award, which will be considered at the annual congress of the society. Additional information may be obtained from the Ophthalmological Society of Egypt, Dar el Hekma, 42 Kasr el Ainy Street, Cairo.

THE *Bulletin* of the Chicago Natural History Museum reports that an unusually large and fine nephrite jade boulder weighing 2,490 pounds has been received by the museum as a gift from James L. Kraft of Chicago. The rounded boulder is oblong-oval in shape with one flattened side and is approximately 4 by 2½ by 2½ feet in its principal dimensions. It is probably the second largest piece yet discovered in the United States and was found in an area about fifty miles southwest of Lander. The boulder formed the peak of an eroded mountain with an elevation of about seven thousand feet. It has been placed on exhibition in the Hall of Minerals. A small section, about half a square foot in area, has been cut from one end and polished so as to bring out the rich dark green color and variegated markings of the specimen.

THE General Electric Company has purchased a one hundred and fifty-five acre plot of ground in Liverpool, five miles from the city of Syracuse, N. Y., and, when necessary materials are released by the government, will build a new plant and make it the headquarters for its department of electronics. Definite plans for the proposed plant have not been made, but preliminary arrangements call for the erection of several buildings so landscaped that it has been suggested that the plant be called "Electronics Park."

THE University of Oxford has established an Honor School of Forestry to take the place of the existing "Pass School" in this subject.

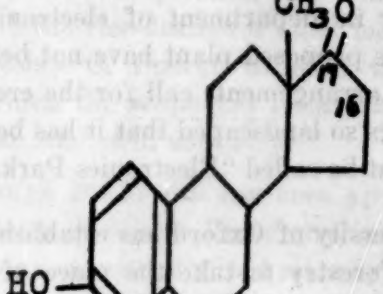
Nature states that at a recent meeting of the Geological Society of London, it was decided provisionally to admit persons between the ages of eighteen and twenty-three as junior associates. Such junior associates will enjoy most of the facilities offered by the society, except that they may not attend discussions relating to the management of the society's affairs, and they will not be entitled to vote at any meeting; they will not continue as junior associates after the close of the calendar year in which they become twenty-three.

THE British Minister of Agriculture has appointed Professor J. A. Scott Watson, who has been Agricultural Attaché at the British Embassy in Washington for the past two years, to be chief education and advisory officer to the ministry. He will take up his new appointment on October 1. According to *The Times*, London, this is a new post, and its creation is in harmony with the intensified effort which is being made in the direction of more agricultural education, research and advice. A few weeks ago the bill setting up the National Advisory Service became law, and this places the control of all county and provincial advisory services in the hands of Mr. Hudson, the Minister. The service will be financed wholly by the Treasury, and the expenditure will be at least £1,000,000 a year. Professor Scott Watson, whose wide experience will be of great value to the new service, has been deeply impressed by the developments of agricultural research in the United States. He has stated that "that country now leads the world in this respect, and has advocated that research workers of Great Britain should be sent there for advanced training and that past contacts should be strengthened in order to bring the full power of science to bear on farm problems."

DISCUSSION

THE CHEMICAL TRANSFORMATION OF ESTRONE TO ESTRIOL (THEELOL)

THEELOL was first obtained in 1930 from human pregnancy urine by Marrian[1] and by Doisy.[2] Browne[3] later isolated it from human placenta. Theelol is the principal estrogenic hormone not only in human pregnancy urine but in human placenta as well. Endo-

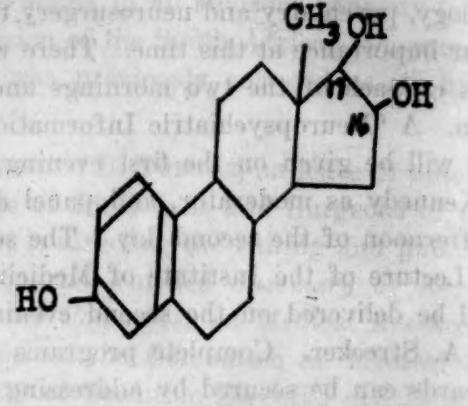


I

crinologists have generally held that theelol (II) arises biologically from the metabolism of estrone (I). That such a conversion can take place is now known with certainty as a result of the recent research of Pearlman and Pincus.[4]

Theelol differs from all other naturally occurring estrogens in possessing a functional group at steroid position 16. Peculiarly, this hormone is found only in the human species. On assay in the intact, immature, female rat it exhibits biological activity[5] much greater than that of its own precursor, estrone. These facts have led to the speculation that the physiological role of theelol may be qualitatively different from that of the other estrogens.

Abnormal estrogen metabolism has long been suspected in the etiology of carcinoma of the genital organs. Three years ago one of us (M.N.H.) commenced work on this problem with the view[6, 7, 8] that such an abnormal metabolism should be sought for generally in the transformation of estrone to theelol and particularly in the formation of an isomeric estriol possessing the unchanged estrone nucleus but



II

differing from theelol in the spatial arrangement of the carbinols at positions 16 and 17. It was in pursuance of this research that the isomeric estriol, isoestriol-A, was prepared.[6, 7] In attempting to make other stereoisomeric estriols of this class the present authors have obtained a small amount of a compound which has proved identical with theelol, the naturally occurring estriol.

We, therefore, wish to report the transformation of estrone to theelol by application of methods of pure organic chemistry. After a seven-step synthesis we obtained a low yield of pure theelol. It crystallized from aqueous methanol in very tiny needles which melted at 268.5–270° (unc.). An authentic sample of theelol kindly supplied by Dr. D. W. MacCorquodale, of the Abbott Laboratories, melted at 268.5–269.5° (unc.). A mixed melting point performed with authentic theelol and our estriol showed no depression. A microanalysis[9] of synthetic estriol gave: C 74.80, 74.76; H 8.46, 8.51 (calculated: C 74.97; H 8.39). There was no depression of the melting point of theelol-3-methyl ether-16,17-diacetate after admixture with the synthetic 3-methyl ether-16,17-diacetate.

MAX N. HUFFMAN
WILLIAM R. MILLER

U. S. STANDARD PRODUCTS COMPANY,
WOODWORTH, WIS.

ON THE INHIBITION OF UREASE BY PENICILLIN[1]

IN a recent announcement, Turner, Heath and Magasanik[2] reported that urease is inhibited by penicillin preparations. The authors suggested the *in vitro* inhibition of the enzyme as a basis for the assay of penicillin. We have repeated their experiments using urease (Squibb) solutions of 0.1 and 0.5 per

[1] G. F. Marrian, *Biochem. Jour.*, 24: 435, 1930.
[2] E. A. Doisy, S. A. Thayer, L. Levin and J. M. Curtis, *Proc. Soc. Exp. Biol. and Med.*, 28: 88, 1930.
[3] J. S. L. Browne, cited by J. B. Collip, *Proc. Calif. Acad. Med.*, 1: 38, 1931.
[4] W. H. Pearlman and G. Pincus, *Jour. Biol. Chem.*, 147: 379, 1943.
[5] J. M. Curtis and E. A. Doisy, *Jour. Biol. Chem.*, 91: 647, 1931.
[6] M. N. Huffman, *Jour. Am. Chem. Soc.*, 64: 2235, 1942.
[7] M. N. Huffman and H. H. Darby, *Jour. Am. Chem. Soc.*, 66: 150, 1944.
[8] The reasons for this hypothesis would be out of place in this communication. It is interesting to note that Hirschmann (*Jour. Biol. Chem.*, 150: 363, 1943) has recently isolated from the urine of a patient with adrenocortical carcinoma a Δ^5-androstenetriol-3(β),16,17—a steroid of the androgen series closely comparable to theelol in the estrogen series.

[9] Performed by Dr. E. W. D. Huffman, Denver.
[1] Contribution from Research Laboratories, Merck and Company, Inc., Rahway, N. J.
[2] J. C. Turner, F. K. Heath and B. Magasanik, *Nature*, 152: 326, 1943.

cent. A low potency preparation containing 1.3 Florey units of penicillin per mg and a sample of crystalline penicillin were used. Typical results are shown in Table 1.

TABLE 1

Urease concentration	Experiment	Mgs NH_3 liberated
0.1 per cent.	Control	0.42
	Crude penicillin (130 units)	0.21
	Crystalline penicillin (1.739 mgs 1650 units per mg)	0.39
0.5 per cent.	Control	2.60
	Crude penicillin (65 units)	0.89
	Crystalline penicillin (1.442 mgs)	2.55

It is clear from the data shown that crude penicillin preparations do, in fact, inhibit urease, but pure samples of the drug do not. It may thus be concluded that the reactions observed by Turner, Heath and Magasanik were produced by the impurities in the comparatively crude preparations of penicillin available to them at the time when they performed their experiments. Since there is no significant inhibition of urease in the presence of as much as 1 to 2 mgs of crystalline penicillin, this approach does not appear to afford a basis for the assay of penicillin.

JOHN V. SCUDI
VIOLA C. JELINEK

ON THE EFFECT OF CONTRAST IN MAKING VISUAL STAR COLOR ESTIMATES

THE writer, at present, is engaged in rechecking visually star colors for all stars visible from latitude 39° N. down to 6th. mag., using low-power, wide-field binoculars and the Yale Catalogue of Bright Stars as reference. The method is to observe a given number of stars, estimating the colors visually; later the list is compared with the Yale Catalogue of spectral classifications and any error in estimates is thus discovered. The writer's color sense, recently tested by the Ishihara method, is a trifle better than normal; and this has been reflected in the accuracy of comparisons, generally running from 80 per cent. to 100 per cent., observing in the heart of the city (Baltimore).

Nevertheless peculiar anomalies occur. On the night of August 19, 1944, at 11h 37 m E.S.T., the color of ψ Capricorni, mag. 4.26, spectral class F_8, was estimated as pale yellow—which was correct. However, the color of ω Capricorni, mag. 4.24, spectral class M_a, also appeared yellow. This star is in the same binocular field with ψ.

Observation of A Capricorni (24 Cap.) mag. 4.6, spectral class M_a, gave a normal, orange-red, Antarean color for this star. Although A Capricorni and ω Capricorni are of the same spectral class, of closely comparable magnitude, and in all visual aspects essentially similar, ω had appeared distinctly yellowish. Reference to an old observation of this star, August 1, 1940, 11 h 35 m E.S.T., showed that at that time the writer had seen the true color without difficulty; but observation then had been with a 2-inch refractor.

Following the suggestion of the earlier observation, ω was re-observed, with a 3-inch refractor. The color now came out quite clearly, the star being like a miniature Antares. It was apparent that the normal color of A Capricorni had been estimated correctly with binoculars because this star stood alone, with no star of comparable magnitude in the same field. When ω was similarly isolated in a telescopic field the true color came out easily. On the other hand, the presence of the yellow star, ψ Capricorni, in the same binocular field with ω, had seriously affected the color estimate of the latter.

This suggests a possible cause, apart from the personal equations, for the widely differing color estimates given for close doubles by the older observers.

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CONSTRUCTIVE MEDICINE

THE recent thought-provoking article by Smith and Evans,[1] attempting to define preventive medicine, reveals how inadequate this term is in modern medical thinking. Though in hearty agreement with the concept of expanding the significance and application of medical practice beyond treatment and prevention of specific diseases, I feel that it might be wiser to apply a new term, rather than to attempt to expand the definition of an old one. As pointed out by Galdston,[2] the term "preventive medicine" will always be limited by the meaning of the word "prevention."

Preventive medicine was a vast step forward in the days when health was defined as that state of being existing in the absence of disease. But medicine has outgrown this older definition of health. Health is more than the absence of demonstrable disease. Health is always relative. It is no more absolute than freedom, slavery, beauty, poverty or wealth. Yet these terms, and many others with similar abstract connotations, are used habitually so loosely that implication of absolute values has crept into our thinking. Health has quantitative attributes involving functional reserve capacities. There are degrees of health. Perfection can be only an ideal abstraction. Perfect health is probably unattainable, though it may be approached. Optimum health implies a maximum reserve capacity for every organ and function of the organism.

[1] G. Smith and L. G. Evans, SCIENCE, 100: 39, July 21, 1944.
[2] I. Galdston, SCIENCE, 100: 76, July 28, 1944.

The treatment of disease is essentially an attempt at the reconstruction of health. As health is relative there is always room for improvement, even though obvious disease is absent. It should be possible to make apparently well people healthier. That healthy babies can be made healthier has been demonstrated by the pediatricians. Such guidance can, and should, be applied to adults. For this type of medical science and service, the name "constructive medicine" has been suggested.[3]

Galdston proposed the term "eubiotic medicine" for the same general concept. It is our feeling that constructive medicine is a preferable term because it will be understood by more people, and because it more simply portrays the objective of approaching an optimal state of health.

Constructive medicine attempts to improve the intrinsic vigor, resistance, and endurance of an individual. It must be applied individually, for it involves direct effort on the part of the patient and something more than the mere control of the environment. One significant aspect of this idea is that it should reduce the great human inertia against preventive activities. To the average individual prevention has a negative connotation. It suggests rules and prohibitions and long series of "don'ts." Furthermore, the actual accomplishments of prophylaxis are demonstrable only statistically. Statistics have little emotional appeal to the average man or woman. We can not prove that this or that measure actually prevented a disaster befalling this or that person. Most people, if left to their own devices, prefer to gamble rather than take the trouble to protect themselves. Therein lies the strength of public health control of the environment; no effort is involved on the part of the individual in obtaining clean, safe food and water.

Constructive medicine, on the other hand, can produce results clearly demonstrable to the individual patient. Improved vigor from better nutrition and raised hemoglobin levels, greater work efficiency[4] and euphoria aided by properly applied mental hygiene are notable to the patient. Constructive medicine is not a panacea which can prevent all ills and quickly make us into a race of supermen. One of the major limitations of good constructive medicine is that it is expensive, for, to be properly applied, it must be individualized. With older persons individualizaton becomes increasingly imperative. Nevertheless, the potential benefits are valuable at almost any price. Though the hope of avoiding all illness or injury is a vain and unobtainable wish, we must not forget that if a man be in really good health prior to an acute infection, or injury, his chances of survival and his speed of recovery are greatly augmented. It is a fundamental principle of geriatric medicine that in mature adults the prognosis in an acute illness is profoundly affected by the condition of the patient before the acute disorder.[5] Lastly, it is possible that all medical therapy could be improved by an attitude which stresses the reconstruction of health, rather than limiting itself to the treatment of disease. We need to be less concerned with the disease and more with the patient.

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[3] E. J. Stieglitz, *Annals Int. Med.*, 18: 89, January, 1943.

SPECIAL ARTICLES

THE FAILURE OF PURIFIED PENICILLIN TO RETARD THE GROWTH OF GRAFTS OF SARCOMA IN MICE[1, 2]

THIRTY-FOUR Bagg albino inbred mice, weighing 19 to 20.5 grams, were implanted with a small graft of a sarcoma native in this strain. During the ten years that this tumor has been transplanted the grafts have grown and brought about the death of every one of the implanted mice of this strain.

Two of the implanted mice were not treated, but were kept as controls. Thirty-two were injected hourly with a solution of Merck's purified salt of penicillin dissolved in normal salt solution. They received doses equivalent by weight to those listed by Merck as most favorable for human beings. The ampules, Merck Lot 193, contained 10,000 Oxford units. The material was stored at 4° C and each ampule was opened as needed.

During the first 72 hours following the implantation of the tumor graft the 32 mice received 120,000 units of penicillin in graded doses as follows: 8 received 8,000 Oxford units each; 8 received 4,000 units each; 8 received 2,000 units each and 8 received 1,000 units each. At the end of this time four mice from each lot were selected for further treatment, and the others received no more injections. The sixteen mice

[1] Aided by a grant made to Dr. Warren H. Lewis from the International Cancer Research Foundation.

[2] The purified Merck's penicillin was supplied by the Office of Scientific Research and Development; the Squibb penicillin was obtained from Lieutenant-Colonel Lind and Captain Romansky, of the Walter Reed General Hospital, and the calcium salt of penicillin was obtained from Dr. Lockwood, of the University of Pennsylvania.

[4] E. J. Stieglitz, Proceedings 8th annual meeting Industrial Hygiene Foundation of America, November 11, 1943.

[5] E. J. Stieglitz, editor, "Geriatric Medicine: Diagnosis and Management of Disease in the Aging and the Aged." Philadelphia: W. B. Saunders Company. 1943.

selected received 40,000 units in the next 24 hours in graded doses of 5,333, 2,666, 1,333 and 666 units each.

At the end of 96 hours the tumors were growing in all the mice. Therefore, two mice were selected from those that had received 8,000 units in the first 72 hours and 5,333 units in the following 24 hours. They were injected during a period of 37 hours with 20,000 units each, amounting to 540 units an hour.

From the above results it can be seen that the 32 mice received from 33,333 units each to 1,000 units each. At the end of seven days all the treated and the untreated mice had tumors of approximately the same size. Fourteen days after the experiment was begun two of the treated mice were dead and the others, both the controls and the treated ones, were moribund.

When it was found that the purified penicillin failed to retard the growth of sarcoma *in vivo* we prepared roller tube tissue cultures similar to those used by Ivor Cornman.[3] In these we found that the purified penicillin failed to damage the sarcomatous or the normal cells even when 120 and 160 units were added to the roller tube culture.

We then decided to compare the action of a more highly purified colorless sodium salt of penicillin (Merck Lot 4R263, 14,000 Oxford units in 9.216 mg) with that of a yellow sodium salt of penicillin (Squibb, Lot 87225).

The pieces of tissue were arranged in test-tubes in a row as follows: kidney, sarcoma, spleen, sarcoma, muscle, sarcoma and heart followed by sarcoma. When the tissue had grown for 24 to 30 hours the medium was withdrawn, fresh medium added and then into each tube was added a known number of units of penicillin dissolved in normal salt solution.

Twenty-four hours later the sarcomatous and the normal tissue were growing abundantly in the cultures that had received 20, 40, 53, 60, 80, 100, 120 and 160 units of the highly purified penicillin. In some experiments the tubes were given a second dose of 80 or of 160 units; nevertheless, the cells continued to grow for a number of days. In the tubes that received the yellow penicillin both the normal and the sarcomatous cells were growing abundantly in the tubes containing 20, 40 and 53 units, respectively, but in the tubes containing 60 and 80 units the tumor cells were damaged while the normal cells were growing. In the tubes that had received 100 and 120 units the tumor cells were killed and the normal cells were damaged.

The tube tissue culture experiments were repeated several times and in each instance they showed that the highly purified penicillin failed to damage the growing normal or the growing sarcomatous cells while the yellow penicillin used in proper dosage damaged the growing sarcomatous cells without injuring the normal cells. These experiments confirm the observations of Ivor Cornman.[3]

From our studies we surmise that the factor present in the less purified sodium salt of penicillin which damaged the sarcoma cells is lost in the highly purified product.

In addition to our studies with the sodium salts we tested one calcium salt. One hundred thousand units of a somewhat yellow colored calcium salt of penicillin, prepared by the Commercial Solvents Corporation, were tested on four mice that had been implanted 48 hours previously with grafts of sarcoma. The four mice tolerated injections of 250, 500, 500 and 750 units, respectively, every two and one-half hours for 28 doses. As the tumors were growing the injections were increased to 1,000 units every two hours. Totally the mice received 11,500, 24,000, 24,000 and 31,000 units, respectively, during 38 injections over a period of 5 days. At the end of 8 days the growing tumors were equally large in the 4 treated and the 4 untreated control mice.

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[3] SCIENCE, 99: March 24, 1944.

SYNTHESIS OF TWO NEW CARBOHYDRATES WITH BACTERIAL PHOSPHORYLASE

THE synthesis of two carbohydrates, which appear to be new analogues of sucrose, has been effected by the use of a phosphorylase preparation from the bacterium *Pseudomonas saccharophila*. This enzyme preparation catalyzes the reversible reaction:

sucrose + inorganic phosphate ⇌ glucose-1-phosphate + fructose,

and has previously been shown to have no action on trehalose, maltose, raffinose, glycogen or starch.[1,2,3,4] Attempts to substitute phosphoric esters of fructose or aldose sugars for fructose have met with no success, nor could any reaction be observed between fructose and maltose-1-phosphate.[5] However, when either *l*-sorbose or *d*-ketoxylose (crude mixture of xylose and ketoxylose) was added together with glucose-1-phosphate to the enzyme preparation, there was evidence of a reaction similar to that observed in the synthesis of sucrose and characterized by the liberation of inorganic phosphate accompanied by a decrease in the

[1] M. Doudoroff, N. Kaplan and W. Z. Hassid, *Jour. Biol. Chem.*, 148: 67, 1943.

[2] M. Doudoroff, *Jour. Biol. Chem.*, 151: 351, 1943.

[3] W. Z. Hassid, M. Doudoroff and H. A. Barker, *Jour. Am. Chem. Soc.*, 66: 1416, 1944.

[4] H. A. Barker, W. Z. Hassid and M. Doudoroff, SCIENCE, 100: 51, 1944.

[5] The maltose-1-phosphate was recently synthesized chemically by W. R. Meagher and W. Z. Hassid (unpublished).

amount of reducing sugar. No reaction took place with *d*-ketoxylose or *l*-sorbose alone, nor in mixtures of glucose-l-phosphate with either *d*-xylose or *d*-tagatose. Fig. 1 shows the changes in inorganic phosphate in the presence of the enzyme preparation with glucose-l-phosphate as the only substrate, as well as in combination with *d*-fructose, *d*-ketoxylose and *l*-sorbose, respectively.

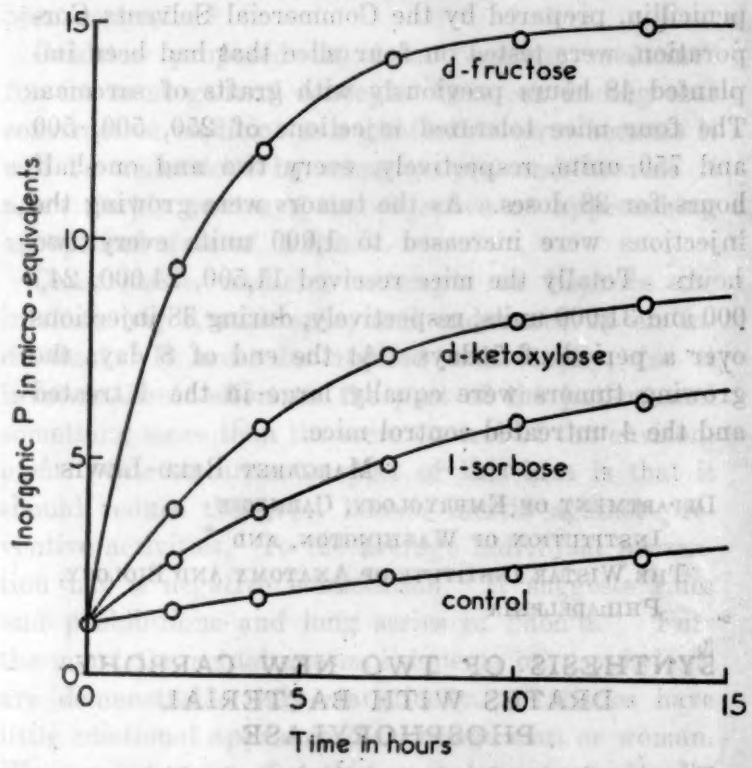

FIG. 1. Liberation of inorganic phosphate during the reaction between glucose-l-phosphate and ketose sugars.

In the hydrolytic decomposition of glucose-l-phosphate, one mole each of reducing sugar and inorganic phosphate is formed. In the reactions under consideration between gluocse-l-phosphate and the ketose sugars, one mole of inorganic phosphate is formed and one mole of reducing sugar disappears. This indicates a net utilization of two moles of sugar (one mole each of ketose and glucose) for each mole of inorganic phosphate liberated. The synthetic compounds therefore appear to be the disaccharides glucosido-sorboside and glucosido-ketoxyloside, respectively. No such disaccharides have ever been synthesized or found in nature. The ketoxyloside is of particular interest since a hexose-ketopentose disaccharide has never been reported.

It will be seen from Fig. 1 that at apparent equilibrium the amounts of phosphate liberated and hence of synthetic products formed are less when *l*-sorbose or *d*-ketoxylose is used than when the reaction involves fructose. Assuming the compounds to be disaccharides, the apparent equilibrium constants at pH 6.5 and 36°, expressed as

$$K = \frac{(\text{inorganic P})\ (\text{synthetic disaccharide})}{(\text{glucose-l-phosphate})\ (\text{ketose})}$$

were found to be 0.013 ± 0.004 and 0.004 ± 0.001 for the reactions with *d*-ketoxylose and *l*-sorbose, respectively.

Although neither of the two new sugars has as yet been obtained in pure form, a study of their properties in mixture with the parent ketoses has revealed that, like sucrose, they are very unstable in acid. Complete hydrolysis was effected by 5 minutes treatment with 1N HCl at 70° and with 0.1 N HCl at 100°. Unlike sucrose, neither compound is attacked by yeast invertase.

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ADSORPTION PHENOMENON OF BETA-CAROTENE

BETA-CAROTENE, dissolved in skellysolve B (65.5-70.5° C.), was adsorbed on activated alumina (200 mesh, Alorco) and the chromatogram was developed with chloroform (Merck's reagent or Baker's C.P.). Two pigment bands were formed. The top, narrow, orange band "T" moved slowly, and the lower, broad beta-carotene band passed rapidly down the column. Skellysolve B, benzene, acetone, ethylene chloride, carbon tetrachloride, trichlorethylene, ethyl acetate, methanol and ethyl ether were tried as developers but did not possess the resolving power of chloroform.

Five commercial, crystalline carotene preparations of different purity were dissolved in skellysolve B and immediately chromatographed. All preparations showed 3.0 to 4.9 per cent. of the T pigment to be present under these conditions. One preparation, declared to possess an extinction coefficient, $E^{1\text{ per cent.}}_{1\text{ cm}}$ (480 mμ) 2270, was considered the purest. A typical absorption curve of pigment T is presented as Fig. 1. In skellysolve B, beta-carotene has its maximum at 450; pigment T at 427 mμ.

It was demonstrated that the T pigment is formed continuously. A beta-carotene preparation was first freed of any alpha-carotene present by adsorption on calcium hydroxide (325 mesh, Marblehead Lime Company) and development with skellysolve B. The beta-carotene band was eluted with a skellysolve B-methanol solution. The water washed and dried (anhydrous sodium sulfate) beta-carotene solution was adsorbed on activated alumina and developed with chloroform. The T band formed. The beta-carotene section of the column was immediately transferred without elution onto the top of a freshly prepared column and washed with chloroform,

whereupon the T band formed again. This transfer was carried out three more times with the same results. In another experiment the beta-carotene was eluted before its transfer to a new column. The same phenomenon was observed. In a third experiment the beta-carotene solution was introduced on the column and washed with chloroform until the two bands were 30–40 mm apart. The vacuum was released for 10 to 15 minutes. Development was resumed until the main band moved another 40 mm and the vacuum again released. Four separate bands of the T-pigment were produced on the same column by this method. It appears that the conversion goes on continuously if the T pigment is constantly removed.

Part of the chloroform was purified by washing successively with concentrated sulfuric acid, dilute sodium hydroxide and water. The dried (potassium carbonate) and distilled chloroform did not effect a separation. Experiments were carried out to ascertain whether the purified chloroform could regain its separatory power. Irradiation of the solution in an open vessel by a Mazda S–4 mercury vapor lamp from a distance of 22 mm for 30 minutes had no effect. The addition of as little as 0.2 per cent. methanol restored the resolving power of the chloroform. Ethanol appeared less effective; acetone, water or hydrochloric acid were of no value. The addition of the alcohols to skellysolve B did not improve the resolving power of skellysolve B.

Previous workers[1,2] judged similar phenomena to be due to isomerization. However, pigment T does not resemble the beta-carotene isomers[3] reported to form above beta-carotene on the column. The present authors believe that under the conditions encountered beta-carotene may undergo isomerization or some other spontaneous change. The chloroform-methanol solution separates the newly formed compound on the column by shifting the adsorption affinity of the compounds. The authors are not familiar with any previous reports demonstrating such a rapid change without the use of specific activation. Hence these brief observations are reported to facilitate further investigation. Specific experiments to establish the reversibility of this change were not carried out.

Resemblance of the absorption spectrum of the T pigment to a combined absorption curve pigment band C3a[4] separated from the carotene fraction of yellow corn, and beta-carotene is observed. The absorption curves of beta-carotene (dotted line) and of pigment C3a (dashed line) are presented as background in Fig. 1. Chromatographically, pigments C3a and T are identical by mixed adsorption on activated alumina

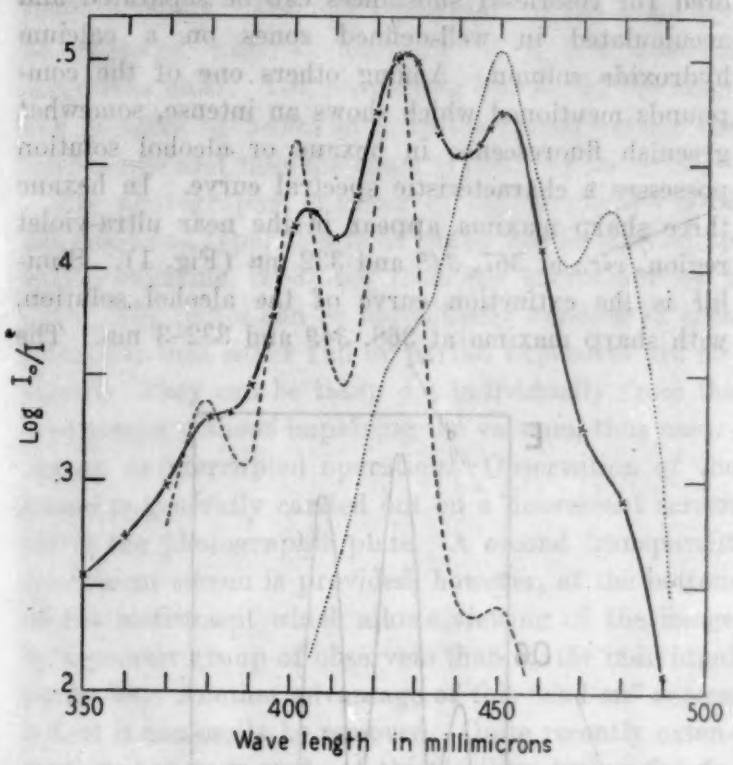

FIG. 1. Absorption Curve of the T Pigment in Skellysolve B. —x—x—x = Pigment T; – – – – – – – = Pigment C3a; ..... = Beta-Carotene.

with non-treated chloroform. Spectrophotometrically, however, this identity is not confirmed.

Since pigment C3a is derived from the carotene fraction of corn its formation during the life of the corn plant, or during the extraction and saponification process may be postulated, in which case it may represent a final stage, whereas pigment T represents an intermediate one and in the stage of transformation. If pigment T is a mixture of beta-carotene and pigment C3a, a separation should have occurred by the adsorption procedure.

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[1] G. P. Carter and A. E. Gillam, *Biochem. Jour.*, 33: 1325, 1939.
[2] L. Zechmeister and P. Tuzson, *Ber.*, 72: 1340, 1939.
[3] A. Polgár and L. Zechmeister, *Jour. Am. Chem. Soc.*, 64: 1856, 1942.
[4] W. Baumgarten, J. C. Bauernfeind and C. S. Boruff, *Ind. and Eng. Chem.*, 36: 344, 1944.

ON THE OCCURRENCE OF A FLUORESCING POLYENE WITH A CHARACTERISTIC SPECTRUM

IT has been frequently observed by members of our group,[1] as well as by other authors,[2] that when some carotenoid containing plant extracts were

[1] L. Zechmeister and A. Polgár, *Jour. Biol. Chem.*, 140: 1, 1941; L. Zechmeister and R. B. Escue, *Proc. Nat. Acad. Sci.*, 27: 528, 1941; L. Zechmeister and W. A. Schroeder, *Jour. Biol. Chem.*, 144: 315, 1942; A. L. LeRosen and L. Zechmeister, *Arch. Biochem.*, 1: 17, 1942.
[2] *Cf.*, for example, H. H. Strain, "Leaf Xanthophylls," Carnegie Institution of Washington, No. 490 (1938), pp. 41 and 123.

chromatographed, certain sections of the column or the filtrate showed fluorescence in ultraviolet light.

It was now found that some of these faintly colored (or colorless) substances can be separated and accumulated in well-defined zones on a calcium hydroxide column. Among others one of the compounds mentioned which shows an intense, somewhat greenish fluorescence in hexane or alcohol solution possesses a characteristic spectral curve. In hexane three sharp maxima appear in the near ultra-violet region, *viz.*, at 367, *348* and 332 mμ (Fig. 1). Similar is the extinction curve of the alcohol solution, with sharp maxima at 368, *349* and 332–3 mμ. The

FIG. 1. Extinction curve in hexane. (Fluorescing compound *ex* tomatoes).

highest maximum is located at about 20 mμ longer wave-length than that of vitamin A and differs by a few millimicrons only from that of vitamin A_2.

The curve as represented in Fig. 1 shows a fine structure in the fundamental band, in contrast to the corresponding curves of the two vitamins mentioned. It is, however, very similar to the extinction curve[3] of anhydro vitamin A ("cyclized" vitamin A),[4] the alcoholic solution of which shows maxima at 392, *371* and 351 mμ. Nearly identical in wave-lengths are the maxima of "iso-anhydro vitamin A" (about 370, *350* and 330 mμ)[3] and of our compound.

The compound under discussion is epiphasic when partitioned between hexane and 90 per cent. methanol. In the mixed-chromatogram test it is adsorbed much below the vitamin A, a little below the β-carotene and in the region of the α-carotene zone. The polyene structure of this compound follows from the nature of its spectrum, from the positive Carr-Price reaction and from its behavior toward iodine. When a hexane solution is catalyzed with iodine and illuminated at room temperature, a subsequent chromatogram shows substantial amounts of isomerization products. Much less is the extent of spontaneous isomerization. The isomers form well-defined zones below the unchanged portion on the Tswett column which fluoresce in ultraviolet light.

Our compound seems to be widespread in nature, since its extinction curve was frequently observed with extract fractions of very different starting materials. It was first obtained when some flowers, belonging to various families, were investigated, *viz.*, *Bignonia sp., Tecomaria capensis, Gelsemium sempervirens* and *Gazania rigens*. The green leaves of wild oat (*Avena sp.*) tested contained only a very small quantity of the compound. The latter could possibly play some part in our nutrition, since it occurs in relatively marked amounts in carrots as well as in fresh or canned tomatoes, and in orange pulp and peel.

To the authors' knowledge well-characterized polyenes of the indicated type have hitherto not been found in the vegetable kingdom. However, it is possible that a fraction of our vitamin A supply may originate from certain plant products whose molecules contain a much shorter conjugated system than the carotene chromophore.

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[3] E. M. Shantz, J. D. Cawley and N. D. Embree, *Jour. Am. Chem. Soc.*, 65: 901, 1943.

[4] J. R. Edisbury, A. E. Gillam, I. M. Heilbron and R. A. Morton, *Biochem. Jour.*, 26: 1164, 1932.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A 100 KV ELECTRON MICROSCOPE

IN the first few years of electron microscopy, development and research was entirely carried out by university laboratories. Soon, however, the commercial value of this new instrument was discovered, and the industrial development started, first abroad and then

in this country too. Very valuable work was done by those industries and for a while it looked as if very little was left over for academic research. Also it seemed as if that little could not be efficiently tackled, if the means, put at the disposal of industrial and academic organizations, were compared.

However, it soon became apparent in the field of electron microscopy, as in other branches of science which were industrially developed, that continuation of academic research is not only valuable, but also necessary. One of the first institutions, or perhaps the first, to recognize this fact and to start a research program of its own in this field was Stanford University. As part of this research program an electron microscope was designed and constructed which shows in several respects departures from known instruments. A brief description of this first Stanford electron microscope seems therefore justified.

The word "universal" has been used before for characterizing two electron microscope designs. If this word is used to mean a versatility of the instrument and its adaptability to different types of observations, then the Stanford microscope can truly be designated as a universal electron microscope. It is a three-stage compound microscope for bright-field and dark-field illumination, for wide-angle stereoscopy, and is provided with means for conversion into a diffraction camera. It has a number of other features which will be mentioned below in a little more detail. Its voltage range is from 30,000 volts up to 100,000 volts in steps of 10,000 volts.

Three-stage magnification was chosen for this instrument because it offers the advantage of observing a wider field at lower magnifications than a two-stage microscope is capable of. Also due to the wide field at our disposal at low magnifications, the necessity of observing the first stage (intermediate) image is eliminated and the construction of the microscope simplified. The optical arrangement differs from the conventional electron microscope inasmuch as the alignment on the optical axis is achieved by means of moving the pole pieces of the magnetic lens instead of the whole coil. The instrument being provided with a fluorescent screen for "end-on" observation, the optical system of the microscope is easily accessible from both ends of the instrument for cleaning or any necessary changes.

The object chamber of the microscope is distinguished from other similar constructions by the greatly reduced volume of its air lock and by the peculiar mechanism of its stage. The stage is suspended on a bracket, provided for a frictionless cross-movement when scanning the surface of the specimen. The cross-movement of the stage is operated from the position of the observer through a hydraulic transmission built with a coarse and fine adjustment. The coarse adjustment is a great help when first scanning at low magnifications. The fine adjustment of the stage can be adjusted with an accuracy of a few hundred Ångstrom units. The supporting bracket of the stage can be tilted by means of a handle placed outside the microscope and thus the stage is tilted up to $\pm 15\frac{1}{2}°$.

The photographic chamber of the microscope is of the magazine type. Up to 24 plates can be stacked up in its magazine, separated from the microscope by a gate. The plates can be individually exposed in such a manner that either full or partial exposures are obtained. They can be taken out individually from the microscope without impairing the vacuum, thus assuring an uninterrupted operation. Observation of the image is generally carried out on a fluorescent screen above the photographic plate. A second transparent fluorescent screen is provided, however, at the bottom of the instrument which allows viewing of the image by a greater group of observers than by the individual portholes. Another advantage of this "end-on" screen is that it can easily be removed. Quite recently extensive use has been made of this facility during the development of an electron microspectroscope for the analysis of minute specimens.

It was found convenient to develop a new type of specimen holder for this microscope. Originally flat discs provided with center holes were used for supporting the specimens or the thin membranes used as "slides."[1] They were later replaced by wire meshes cut to a circular disc of convenient diameter.[2] In the new design wire screens are maintained as the supporting element; but, instead of being flat, they are cup-shaped and inserted in small commercial eyelets. There is a flat surface of 1 mm diameter, perpendicular to the optical axis, which is the observed part. The advantage of this type of specimen holder is that it is easy to handle, it is "polarized," *i.e.*, there can not be any confusion between front and back surface, and furthermore, it is easy to file for further use. The "cartridges" or supports of other electron microscopes can easily be modified for the use of this new type of specimen holder.

Following the practice, which becomes more and more accepted, of caution in stating the resolving power of the instrument, it will be mentioned that the instrument described herein has a resolving power of better than 50 Å.U. It has been used up to now for a series of investigations from which the following might be mentioned: ferromagnetic domains, poliomyelitis virus, different bacteria and their modifica-

[1] Ruska, 1934, Marton, 1934.
[2] Marton, 1940.

tion under action of physical, chemical or biological agents, etc. The detailed account of these investigations will be published elsewhere.

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A WORKING MODEL OF THE HUMAN CIRCULATION

THE circulation schema here pictured and described has proved helpful in explaining the complexities of the circulation to beginners in physiology. Its construction is simple and inexpensive[1] and its relation to the human body is much more direct than that of commercial models.

Most of the essential features are visible in the illustration. The heart consists of four rubber bulbs operated by cross-bars attached to a central rod, the sequence of events being as in the heart itself. Small light bulbs flash on at the proper times to represent the activation of the S. A. and A. V. nodes. The connection of blood vessels with heart is through one-way valves, glass flutter valves being employed which can be seen in operation. Glass tubing is used for blood vessels, the fluid being appropriately colored, methylene blue for venous and Congo Red for arterial blood. Peripheral resistance is obtained by stop-cocks representing arterioles; in the systemic circulation one serves muscle tissue, the other is located in the splanchnic region. Anatomic regions of the body are painted in lightly, as background, on the panel. Beyond the arterioles a capillary network is indicated and by a proper arrangement of the tubes the emerging blood has the opposite color of that entering, i.e., changes from blue to red in the pulmonary, and from red to blue in the systemic circulation. The aorta is cannulated and connected to a manometer writing on a kymograph drum. Heart sounds are reproduced by electrical contacts and a loud speaker.

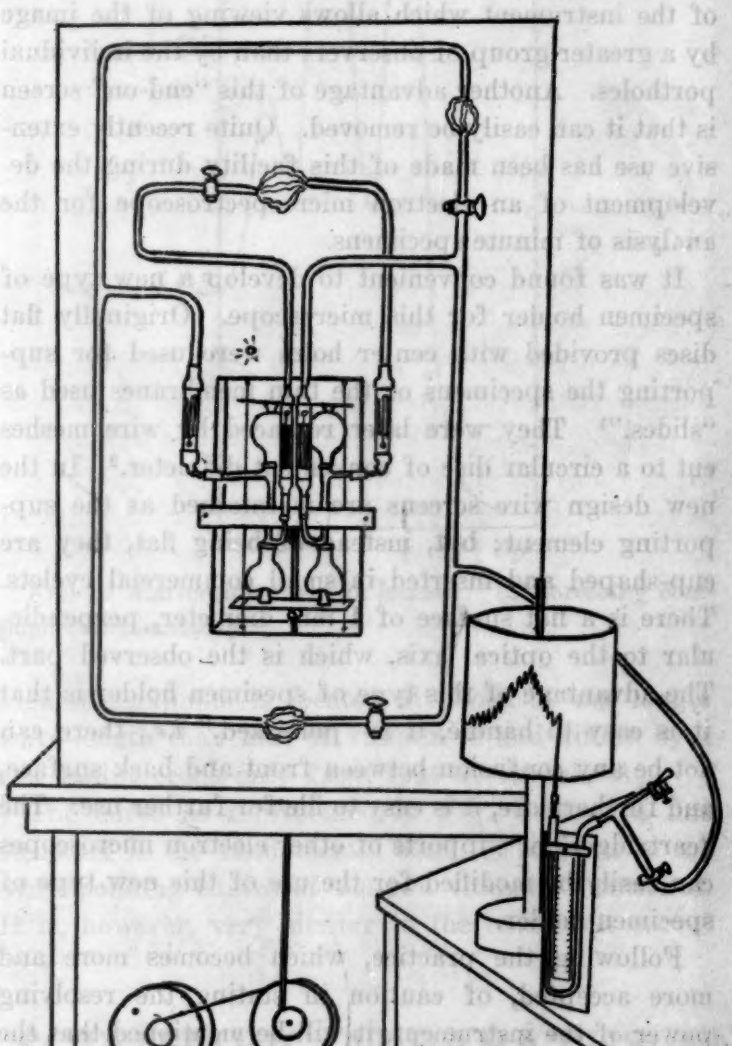

FIG. 1. This drawing shows how the effects of a simulated injection of adrenalin may be demonstrated. The motor has been speeded up and the stop-cocks in the systemic circulation narrowed.

[1] The device may be purchased from the Denver Fire Clay Company.

Among the physiologic events which can readily be demonstrated are the sequence of events in the cardiac cycle, the details of the circulation and the effect of various factors on the blood pressure, such as alterations in the cardiac output, variations in the peripheral resistance, the shunting of blood from visceral regions to muscles during exercise, the loss of blood in hemorrhage, etc.

It is evident that, except for motor, kymograph and loud speaker, no expensive items are required. The motor can be dispensed with, manual operation being satisfactory, a kymograph is available in most laboratories and a loud speaker can be found in almost any basement.

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